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Emissions of Organic Pollutants from Traffic and Roads: Priority Pollutants Selection and Substance Flow Analysis

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Introduction

Large quantities of organic pollutants (OPs) are emitted from vehicles, fuels, road and roadside construction materials and they are accumulated on road surfaces. Contaminated road runoff is transported to surface waters, where the OPs may pose a threat to aquatic ecosystems. Therefore, tools that facilitate the prioritization of hazardous compounds for further studies through substance flow analysis (SFA) need to be developed

Aim and objectives

The specific goals of this research were to:

- Identify sources and quantify uses of OPs present in road runoff
- Propose a list of Priority Pollutants (PPs) with contaminants intended to be studied further in investigations concerning their optimal elimination from road runoff
- Compounds from the list of PPs is a subject for Substance Flow

Methods

To identify and classify possible sources of OPs from road environments, as well as to perform the selection of PPs to be included in the SFA, the following methodology was implemented (Figure 1).

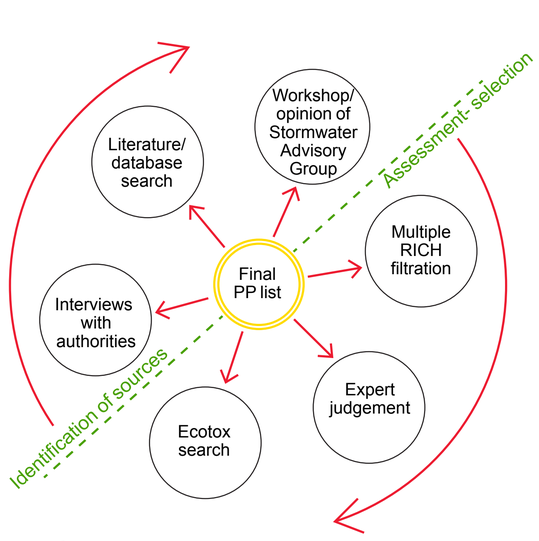


Figure 1. PP selection process

Selection criteria

Criteria supporting evaluation of collected data and the choice of PPs include:

- Risk of emission/leaching of pollutants from sources into stormwater systems.
- Emission of specific substances or groups of substances from more than one source in road environments.
- Estimation of use and quantities of OPs emitted from vehicles, fuels and construction materials in Sweden and in the EU.
- Hazardous effects on aquatic environments and humans.
- Availability of analysis methods for chosen substances.

RICH

The RICH (Ranking and Identification of Chemical Hazards) tool was used to provide information regarding physico- chemical and biological properties registered for a wide range of substances occurring in stormwater. The Figure 2 presents sorting steps in the chemical hazards assessment, performed by RICH.

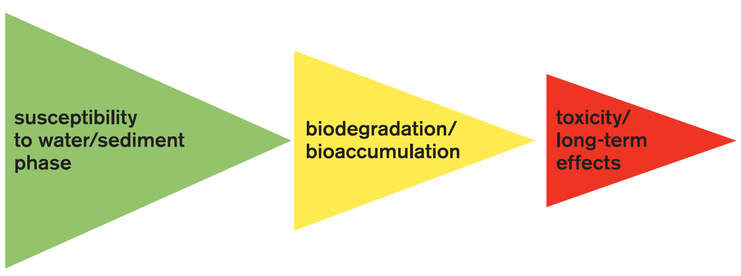
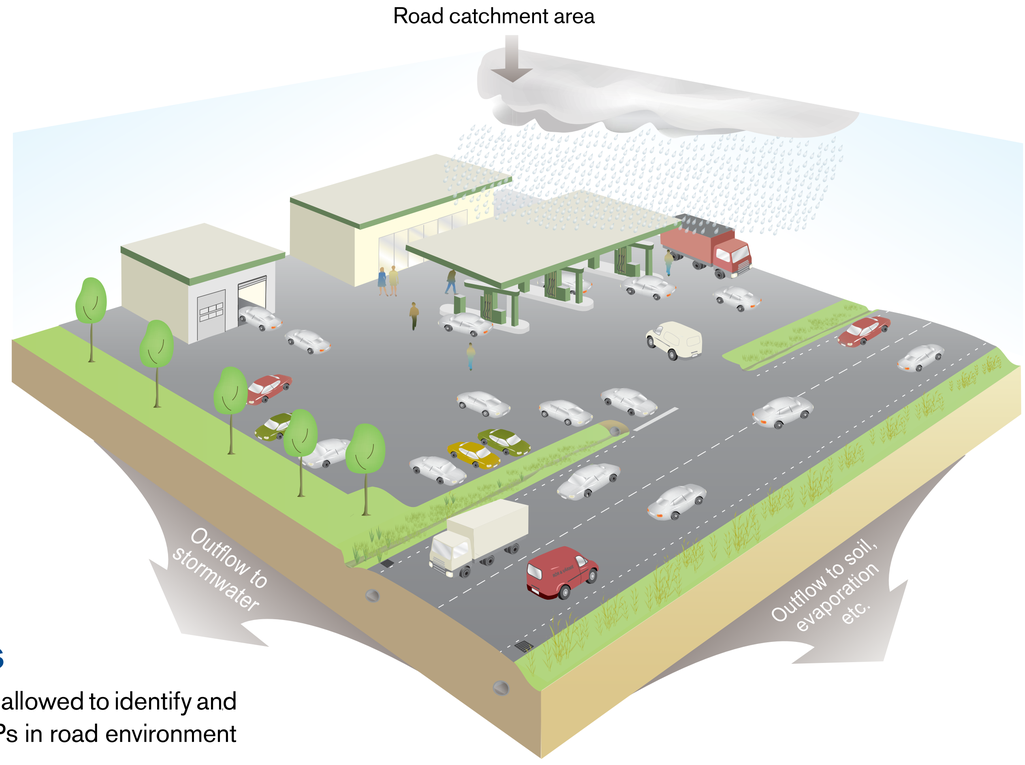


Figure 2. The RICH tool filtration process (adopted from Baun, Eriksson et al. 2006)



Results: Selection of PPs

The first screening stage for PPs selection allowed to identify and classify the most important sources of OPs in road environment (Table 1).

Table 1. Sources of OP emission identified in traffic environment

VEHICLES		
tires wear/debris		phthalates, AP/EOs (alkylphenols/alkylphenols ethoxylates), n- alkanoic acids, n- alkanes, oleic acid, steranes, hopanes, natural resins, polyclic aromatic hydrocarbons (PAHs)
brake lining		PAHs, oxy- PAHs, polyglycol ethers, benzaldehydes, benzoic acids, oleic acids, n- alkanoic acids
vehicle components	**undercarrige**	bis(2-ethylhexyl) phthalate (DEHP), PAHs
	plastic components	DEHP, NP/EOs (nonylphenol/nonylphenol ethoxylates), amines
	paint/ lacquer	DEHP, NP/EOs
vehicle detergents/cleaning agents		phthalates, NP/EOs, naptha
fuels	**lubricant oil (gear box, engine) hydraulic oil, chemical spillage**	PAHs , phthalates, NP/EOs, naptha, bisphenol A
	exhaust gases/ combustion of fuels (gasoline/diesel/LPG,CNG)	PAHs and related substances, aldehydes, alkanes, phenols
ROAD CONSTRUCTION MATERIALS/PARKING LOTS/ TUNNELS/CAR WASH		
penetration grade bitumen/asphalt		phthalates, NP/EOs, PAHs, amides, amines
cement/concrete		NP/EOs
road dust (tires, fuel, oil, asphalt)		phthalates, alkylphenols (APs), n- alkanals, n- alkanes, n- alkanoic acids, benzoic, oleic acids, PAHs, Oxy- PAHs, amides, amines, resin acids
road paints		phthalates, AP/EOs
vehicle washing facilities		AP/EOs

Further analysis and RICH filtration of OPs involved established selection criteria and resulted in PPs presented in Table 2.

Table 2. Examples of identified PPs

PAH 16	**Phthalates**	**Amides**
phenanthrene	benzylbutylphthalate (BBP)	behenamide
fluoranthene	dibutylphthalate (DBP)	ethylenebis oleamide
pyrene	diethylhexylphthalate (DEHP)	n-stearyl erucamide
Oxy- PAH	**Phenols**	**Alkane Aldehydes C1-C40**
9,10-anthracenedione	4-nitrophenol	crotonaldehyde
fluorenone	4-t-octylphenol	formaldehyde
hydroquinone	bisphenol A	methylbenzaldehyde
Alkanes C1-C40	**Amines**	**Antioxidants**
eicosane	bis(4-octylphenyl)amine	2,6-di-tert-butylphenol (2,6-DTBP)
heptacosane	benzenamine	butylated hydroxytoluene (BHT)
hexacosane	**Naptha (petroleum)**	tert-butylhydroquinone (4-TBP)

Results: SFA

SFA is an analytical method developed for quantitative assessment of individual substances through a given system, specified in space and time. For this study, system boundaries are defined in Table 3.

Table 3. The system boundaries for SFA

SUBJECT	SPACE FRAME	SOURCES	TIME FRAME
Organic pollutants	Road area Gårda	Vehicles, road surface	1 year

So far, an SFA for PAHs have been performed. The PAHs are divided into low-, medium- and high- molecular weight compounds. Preliminary results are presented in Figure 4.

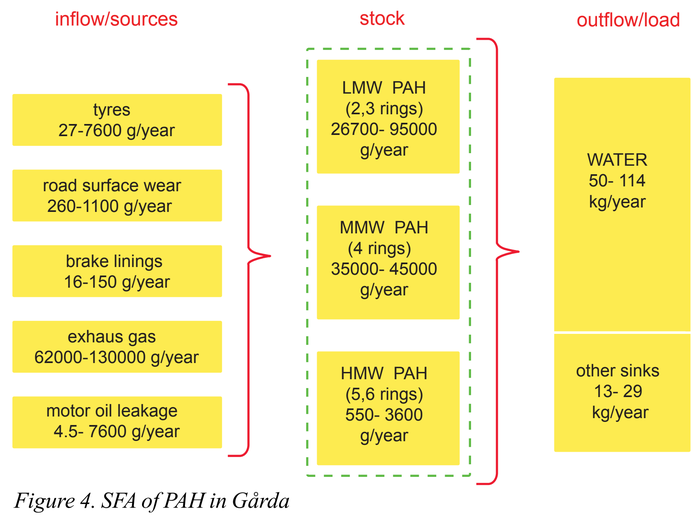


Figure 4. SFA of PAH in Gårda

Conclusions

- Ten groups of OPs to focus on in the further studies has been selected by the iterative PP evaluation method of around 1200 specific organic compounds likely to be emitted from the road and traffic environment.
- Each stage of methodology encountered limitations regarding availability of data
- The SAF of PAHs showed that significant amount of OPs are continuously emitted into aquatic environment

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